SIMS MEASUREMENTS OF H IN DOS GENESIS COLLECTORS: DIFFERENCES IN PHYSICAL PROPERTIES OF THE COLLECTORS AFFECT THE RESULTS.

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Introduction: Acquiring precise and accurate measurements of solar wind (SW) using secondary ion mass spectroscopy (SIMS) on Genesis collectors has been challenging, mostly due to standardization. One way to standardize a SW measurement is to implant a known amount of a standard into a Genesis collector chip (deeper than the SW) and to measure the SW and standard in the same SIMS measurement [e.g., 1]. Alternatively, a standard could be implanted into a separate piece of the same material and the SW and standard be measured under the same conditions. In previous work on H in Diamond on Silicon (DoS) collectors, we found that standardizing by these two methods gave different results [1]. SIMS data from DoS wafers are difficult to accurately quantify as the SW is collected by the wafer’s diamond-like carbon (DLC) coating. The film is extremely retentive of volatiles, and carbon has low backscatter during SW collection with relatively few potential mass interferences during analysis [2] but is chemically and physically heterogeneous, an issue not fully appreciated before flight [3]. This study explores techniques developed by AJGJ, in which various parameters of the measurements are used to evaluate structural heterogeneity of the Genesis DoS collectors [3].

Our solar wind measurements: H fluence was measured by depth profiling in DoS collector chips from the Genesis B/C, H, L, and E arrays using the Cameca ims 1280 ion microprobe at the University of Hawai‘i at Mānoa. The measurements were standardized by implanting a standard dose of H (nominally $6x10^{15}$ atoms per cm^2) in a single radiation into flight samples of B/C and H arrays (deeper than the SW), a blank DoS chip, and two apatite grains with well-determined H concentrations. Each measured profile was integrated over the entire depth and background-subtracted. The fluence of the implant was calibrated against the intrinsic H in the apatites. The integrated B/C and H depth profiles were then compared to the integrated, calibrated, standard profile from the same measurement (internally standardized). Because the standard was not implanted into the L or E array samples, the fluences were determined by comparing the integrated solar wind profiles with the integrated profiles of the standard implant in the blank DoS collector (externally standardized). We also reduced the B/C and H profiles against the external standard.

Results and Discussion: When the B/C and H array data are reduced with the external standard, the inferred SW H fluences are higher than those calculated with the internal standard (Table 1). This is because the integrated H/C ratios for the profiles of the standard implants into the Genesis chips were higher than that for the external standard. We considered two end-member possibilities to explain this situation (although both could be happening): 1) SW H affected the density and H ionization efficiency of the Genesis collectors, and 2) the properties of the Genesis collectors and DoS standard chip were initially different. If the SW had affected the Genesis collector chips, we would expect the B/C array to be altered more than the H array, because the SW fluence in the B/C array is nearly 3x higher than in the H array. However, the inferred fluence for the H array differs by 18% for the two methods, while the B/C array differs by 13%, implying less modification in the B/C array. Also, the standard was implanted deeper into the H array than the B/C array. These observations suggest that the SW is not responsible for the differences between the two standardizations. The second possibility implies that the H ion yield is a function of the structure and/or composition of the collector material. To test this theory, we plotted the relative sensitivity factor (RSF) for H/C against the $^{12}C_2/^{12}C$ ratio for each SW measurement [e.g., 3], where the $^{12}C_2/^{12}C$ value is an average of the ~100Å below the SW implant. The comparison between these two variables showed a linear correlation and the equation of the line was used to recalculate the RSF’s for each measurement so they fell on the line; thereby reducing the scatter of the data. A correction factor was calculated by comparing the new RSF’s with their original; this factor was applied to each of the integrated solar wind values to calculate new fluences (Table 1). The RSF corrected, externally standardized B/C and H array fluences are lower and more similar to the internally standardized B/C and H array measurements. Our modeling suggests that differences in the physical properties of the different DoS collectors provide the best explanation for the differences between internal and external standardization. Table 1 may not be final values; however, future work includes modeling the shapes of the SW H and standard implants using SRIM to determine if the scatter in the data could be partially due to variation of Si in the collectors [e.g., 3].

Array	Genesis Ion Monitor[4]	Original External Std	Original Internal Std	RSF corrected
B/C	2.06	1.82E+16	1.61E+16	1.67E+16
H	0.64	6.57E+15	5.55E+15	6.04E+15
L	0.915	7.31E+15	-	6.97E+15
E	0.473	4.45E+15	-	4.05E+15

References: [1] Koeman-Shields E. C. et al. (2016) *LPSC XLVII*, Abstract #2800. [2] Jurewicz A. J. G. et al. (2003). *Space Sci. Rev.* 105:535-560. [3] Jurewicz A. J. G. et al (2017) *LPSC XLVIII* #2120. [4] Reisenfeld D. B. et al. (2013) *Space Sci. Rev.* 175:125-164.
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